

Slides to accompany
the presentation of
Steven R. Ditmeyer

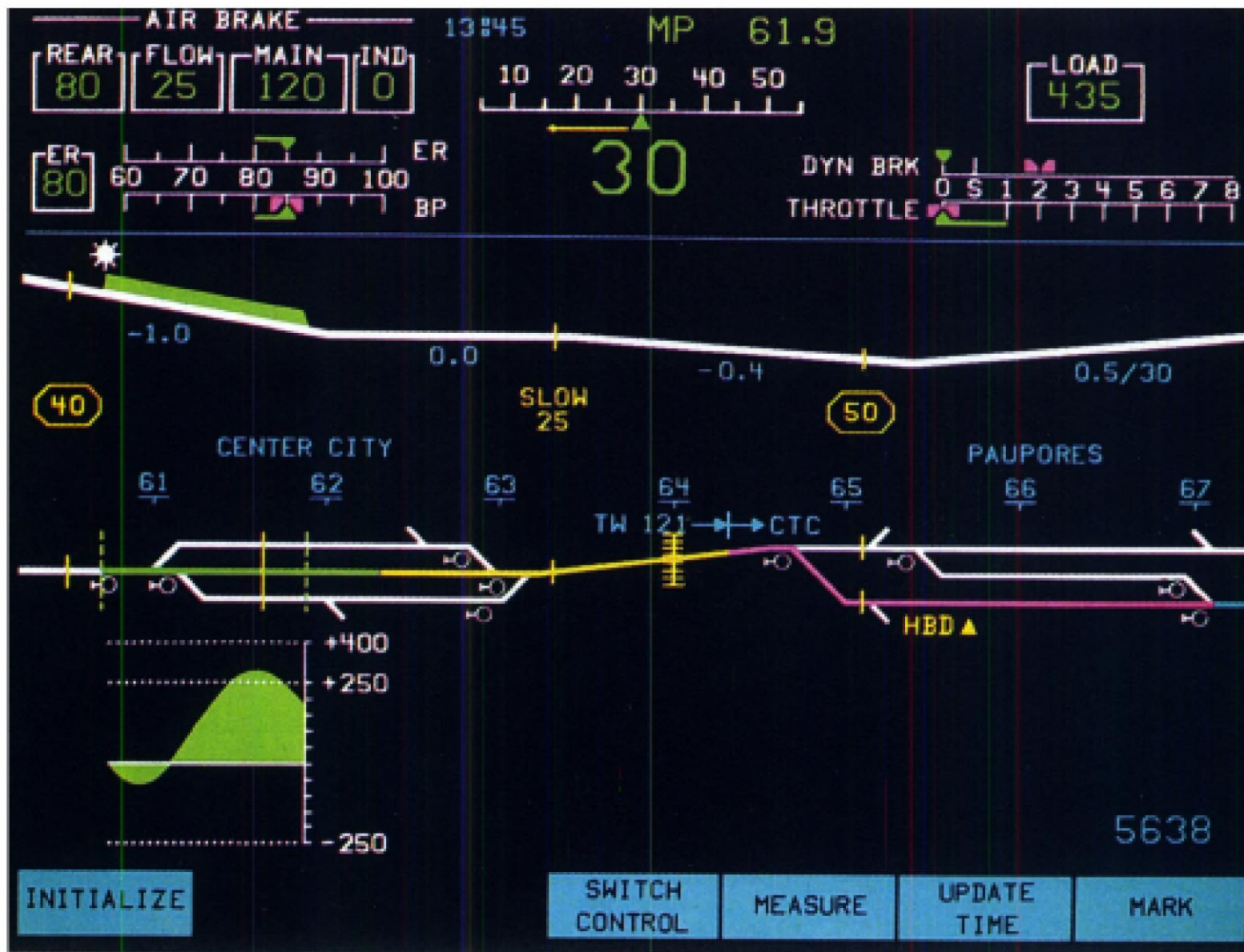
at the
National Transportation Safety Board's
Positive Train Control Forum
February 27, 2013

Locomotive Cab Displays

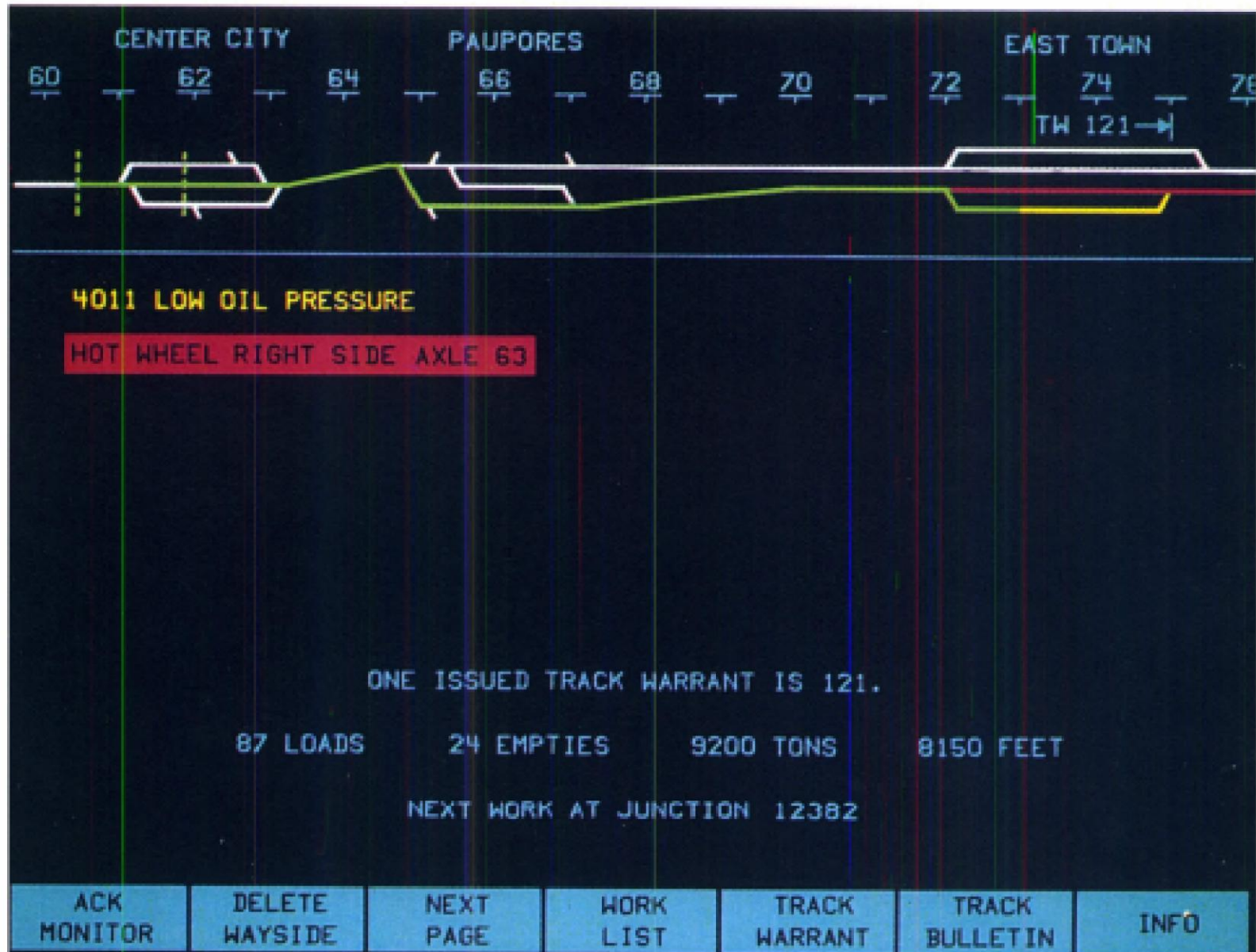
Coordinated displays of relevant information to train crews in both graphical and textual formats:

- Train position and speed
- Current movement authority
- Current and upcoming route profile
- Train consist, with special handling instructions
- In-train forces
- Actual and recommended throttle and brake settings
- Locomotive and car health
- Set-out and pick-up instructions

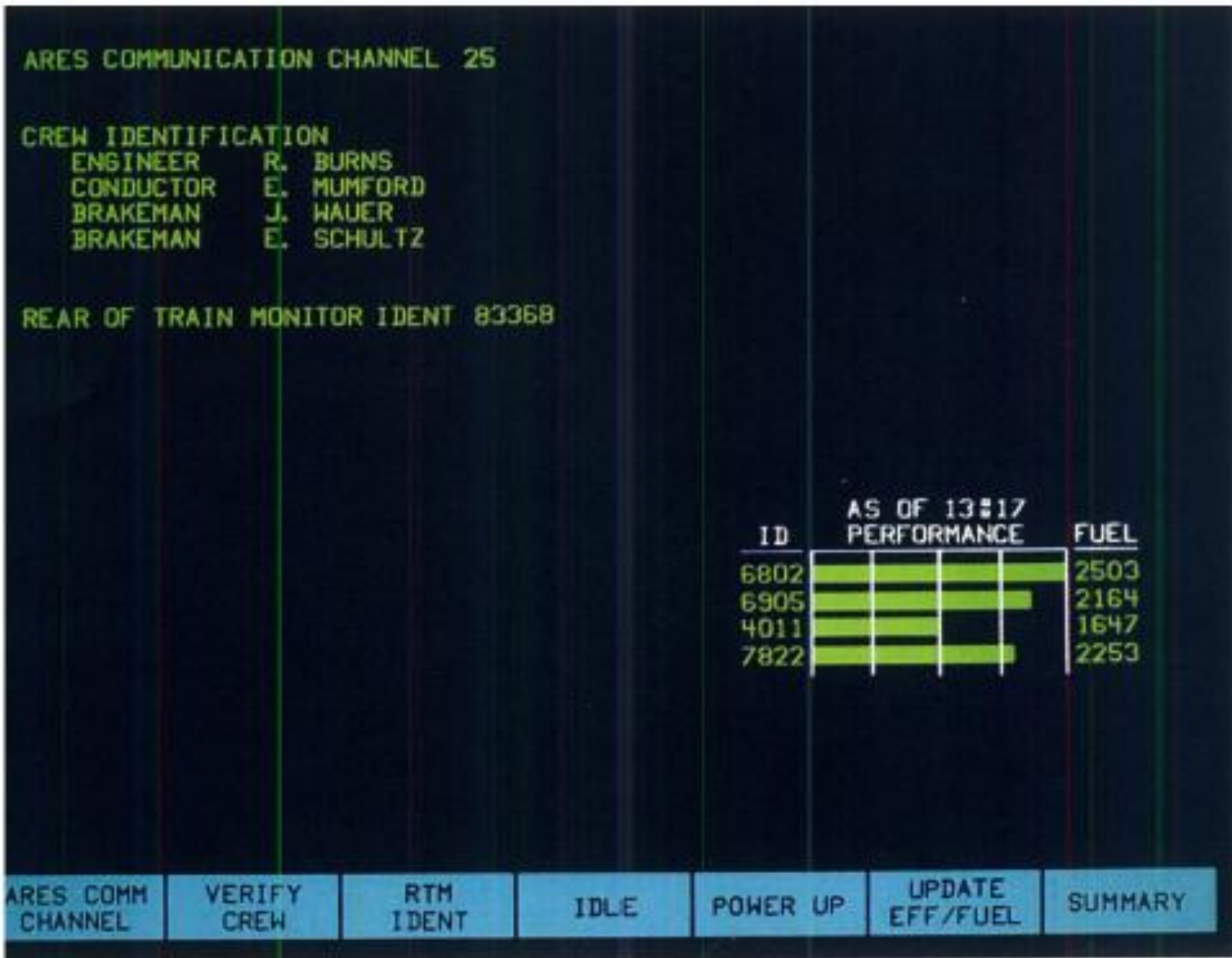
ARES Locomotive Cab Display



ARES Locomotive Cab Display



ARES Locomotive Cab Display



ARES Locomotive Cab Display

						
SEQ	NUMBER	L/E	KIND	TONS	DESTN JCT	SPECIAL
1	6802		SD-40-2	120		
2	6905		SD-40-2	120		
3	4011		B30-7A	120		
4	7822		SD-40-2	120		
5	TTWX974548	L	FU8/050	055	16001	
6	TTWX990456	L	FU8/050	067	16001	
7	TTX 159664	E	FT8/050	034	02201	
8	TTX 252793	L	FT8/080	087	16001	
9	TTWX991422	L	FU8/100	084	16001	HAZARDOUS
10	TTX 156511	L	FT8/080	078	16001	
11	TTX 154138	L	FT8/080	089	16001	
12	FEC 2848	L	FU8/050	078	16001	
13	TTX 253811	L	FT8/050	067	16001	
14	TTX 102312	L	FU8/050	085	16001	
15	WP 8898	L	FU8/050	084	16001	
16	TTX 251770	L	FT8/100	074	12381	
17	TTX 250312	L	FT8/080	084	12381	
18	TTX 604629	L	FT8/050	056	12381	
19	STTX911855	L	FT8/050	074	12381	
20	TTWX992799	L	FU8/100	097	12381	
21	TTWX991425	L	FU8/050	090	12381	
22	TTX 156101	L	FT8/080	074	12381	
23	TTX 251793	E	FT8/080	025	16021	
24	TTWX996648	L	FU8/080	088	16021	
25	WP 7643	E	FT8/100	024	60016	
26	BN 221057	L	B5/050	057	60016	
27	BN 317105	L	B9/060	067	60016	
PREVIOUS PAGE		NEXT PAGE		WORK LIST		SUMMARY

Track Forces Terminals

- Provide the interface for communications to and from roadway workers
- Can be laptop computers or PDAs
- Enable crews to determine future track occupancy and to request “track and time” from dispatcher
- Display current movement authority
- Enable crews to place slow orders and to transmit administrative data
- Should greatly improve productivity of roadway workers by eliminating uncertainty of track availability

Locomotive Health Monitoring Systems

- Provide real-time and historical internal health monitoring data for engines, electrical systems, dynamic and air brake systems, hydraulic systems, exhaust systems, fuel tanks
- Transmit health data to locomotive cab, and over the data link to the control center, locomotive scheduling center, and locomotive shops
- Include event recorders
- Allow collection of health data for maintenance-based decision making
- Improve reliability, availability, and utilization rate of locomotives

Work Order Reporting

- Instructions sent from control center to train crews to set out and pick up loaded and empty cars en route
- On-board train consist updated automatically based on crew acknowledgement of work order completed
- Train consists in control center and central computer data bases also updated in real time
- Location of set-outs automatically recorded
- Customers can be automatically notified of impending or actual car placement
- Important for establishing “custody chain” of shipments

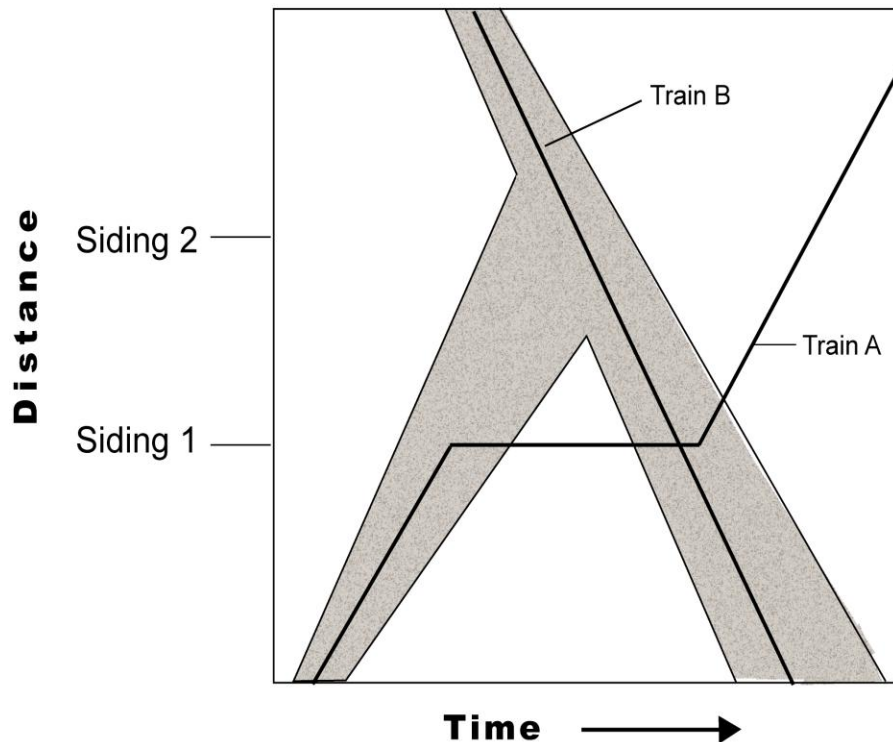
Tracking Hazmat and Other Shipments

- AEI confirms the locos and cars on each train and sends it to operating data system
- DGPS receiver determines location of the loco to within 1-2 meters and speed to within 1-2 km/hr and data radio transmits it back to dispatchers and operating data system
- Work order reporting system confirms set-outs and pick-ups and sends them to operating data system
- Data in train location, train consist, work order reporting, and waybill data bases can be merged to ***precisely*** locate ***every*** car/shipment
- Authorized parties (at railroad, shipper, and appropriate local/state/federal government agencies) can inquire about precise car/shipment location

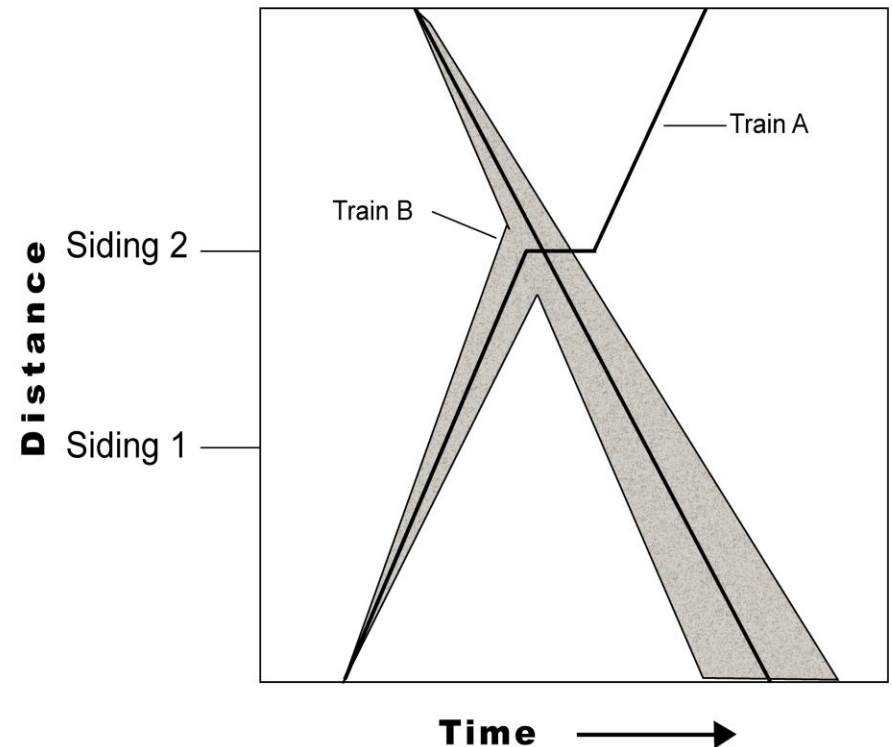
How ARES PTC Permitted More Efficient Train Meets

Accurate projections of train location reveal opportunities to reduce meet/pass delays.

Without Accurate Projections



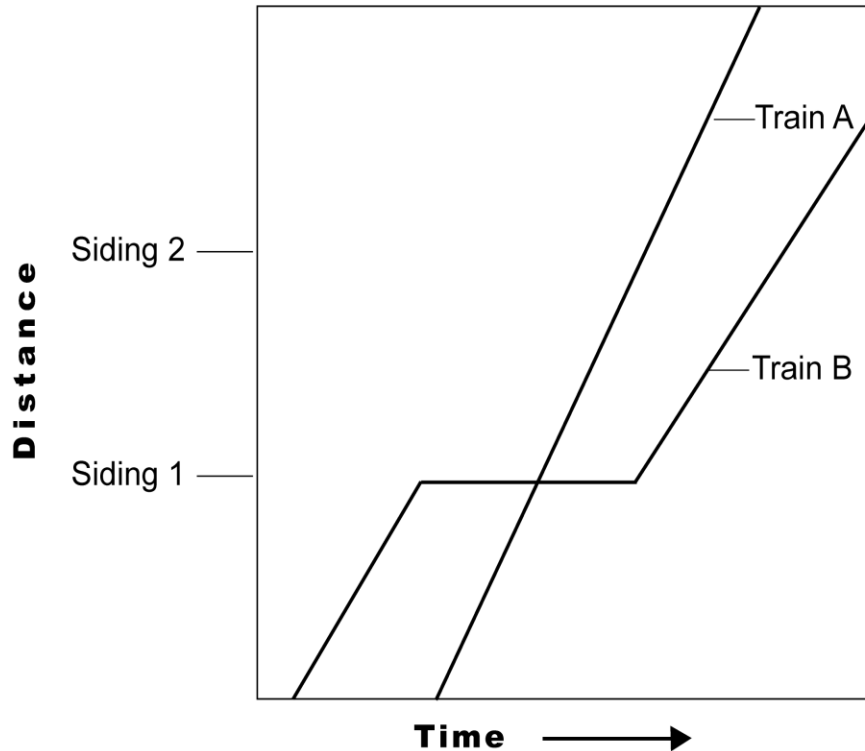
With Accurate Projections



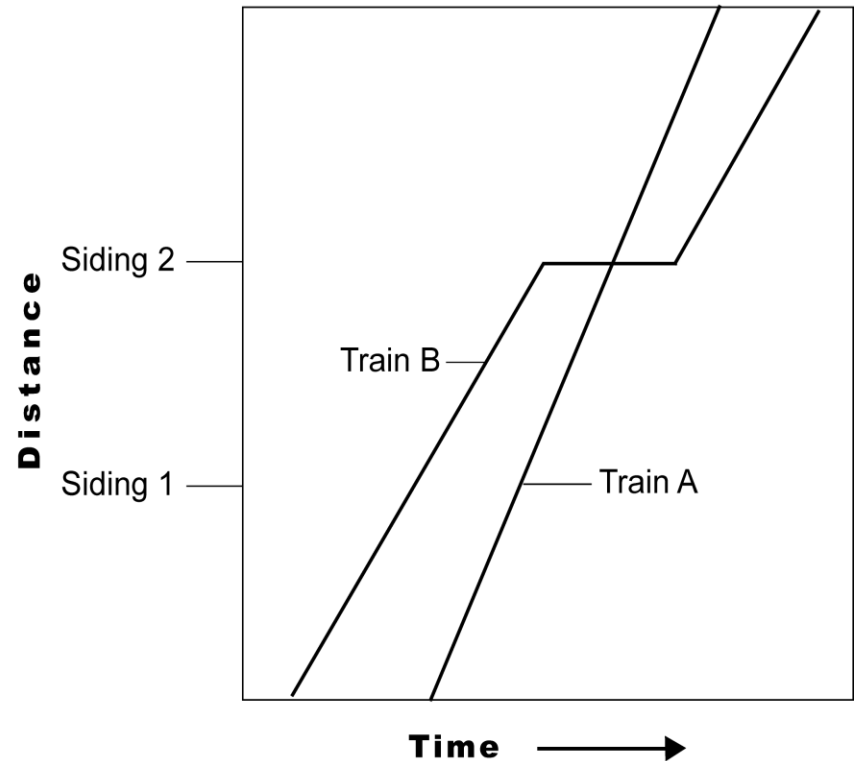
How ARES PTC Permitted More Efficient Train Passes

The ability to operate with short headways can reduce meet/pass delays.

With Greater Headway



With Less Headway



How the ARES PTC Control Center Helped Dispatchers

- Reduced dispatchers' *communication load*
- Improved dispatchers' *communication efficiency and speed*
- Increased dispatchers' *communication precision*
- Radically changed dispatchers' *communication focus*:
 - Traffic planning and problem solving replaced information gathering and movement authorization as dispatchers' primary tasks

PTC Positioning

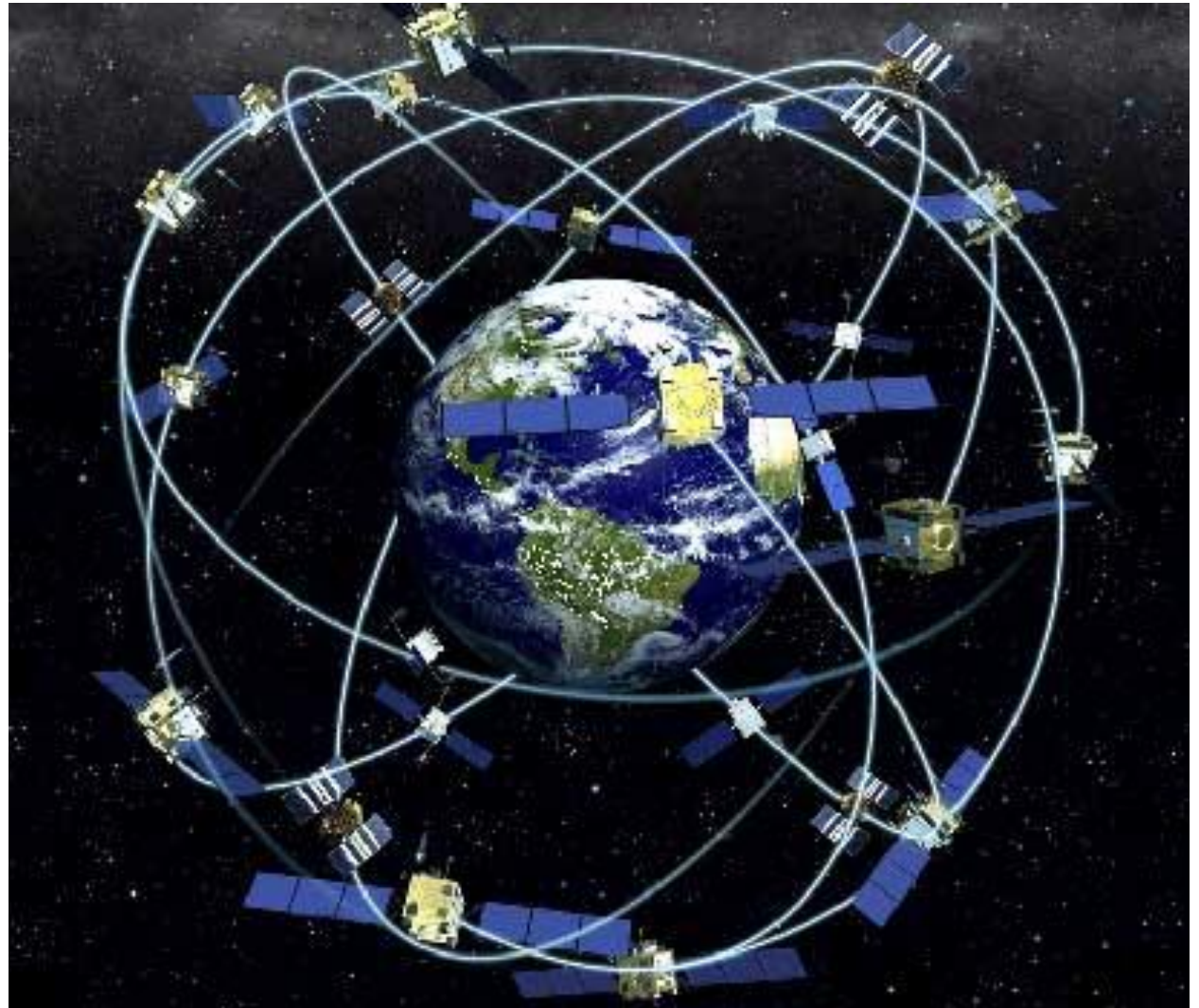
- Multiple inputs on train position are integrated:
 - DGPS
 - Odometer
 - Switch position indicators
 - Digital track map in control center and on-board computers
- Train and roadway worker position is sent over the data link to the control center; movement authorities are sent over the data link from the control center to trains and roadway workers
- Track centers are 4 m apart, which requires 1-2 m positioning accuracy (i.e., DGPS)
- Accurate positioning also needed at clearance points at switches

Global Positioning System

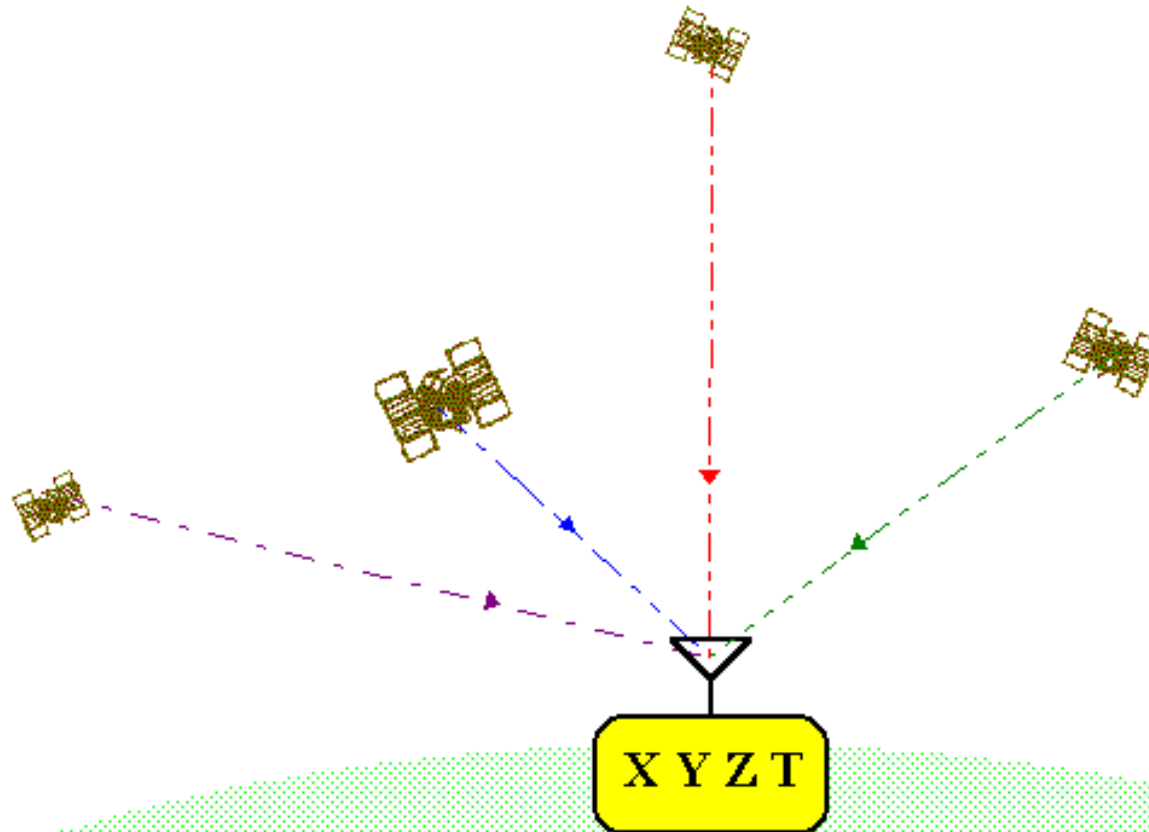
GPS

GPS Nominal
Constellation:

- 24 satellites in
6 orbital planes
- 4 satellites in each
plane
- Altitude 20,200 km
- Inclination 55 degrees



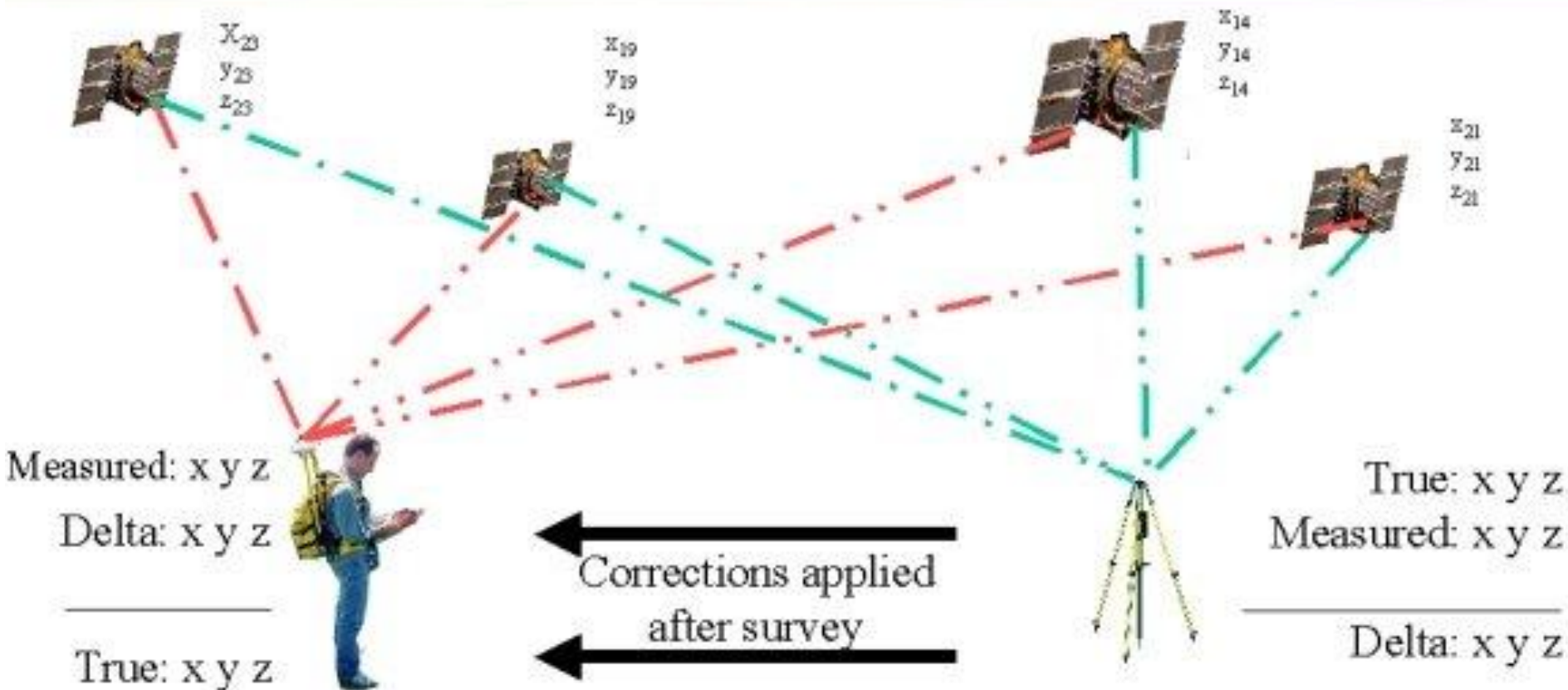
GPS Positioning



The Global Positioning System

Measurements of code-phase arrival times from at least four satellites are used to estimate four quantities: position in three dimensions (X, Y, Z) and GPS time (T).

Differential GPS



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Ocean Service
National Geodetic Survey



Positioning America for the Future

Nationwide Differential GPS

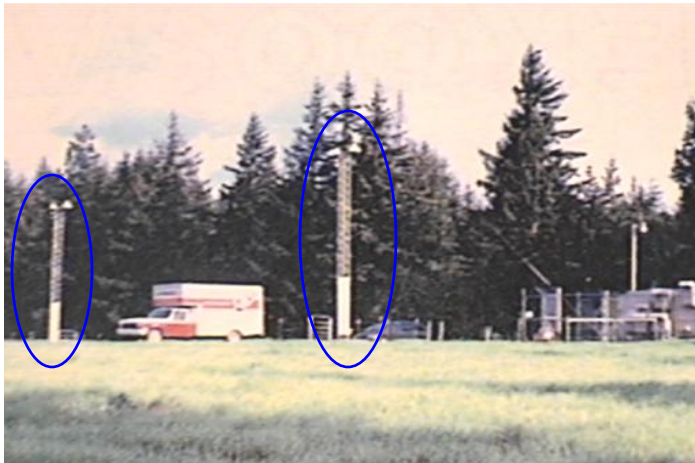
- GPS satellite constellation provides 10 m accuracy
- NDGPS is an augmentation of GPS providing 1-to-2 meter positioning accuracy
- NDGPS monitors GPS integrity; users receive warning of GPS degradation within 5 seconds
- Currently operational with single coverage over 90% of continental US and double coverage over 45%
- NDGPS signals available to anyone with proper receiver; no user fee
- Managed and monitored 24/7 at USCG Navigation Center, Alexandria, VA

Nationwide Differential GPS

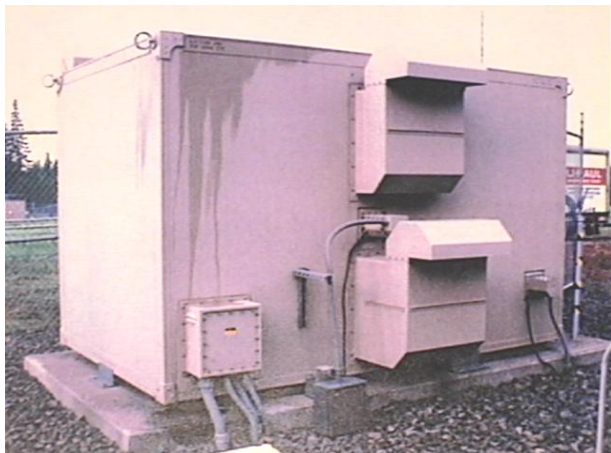
- Uses decommissioned USAF Ground Wave Emergency Network (GWEN) sites to send out correction signals
- International standard (RTCM 104) developed by US Coast Guard; used in 40 countries
- Joint project with FRA, USCG, FHWA, OST, USACE, TVA, states, and others
- Date for Full Operational Capability with double coverage uncertain due to funding limitations
- High-Accuracy DGPS (HA-DGPS) developed and tested by FHWA and USCG at Hagerstown, MD site: 10-20 cm accuracy

Converted GWEN to NDGPS

Appleton, WA

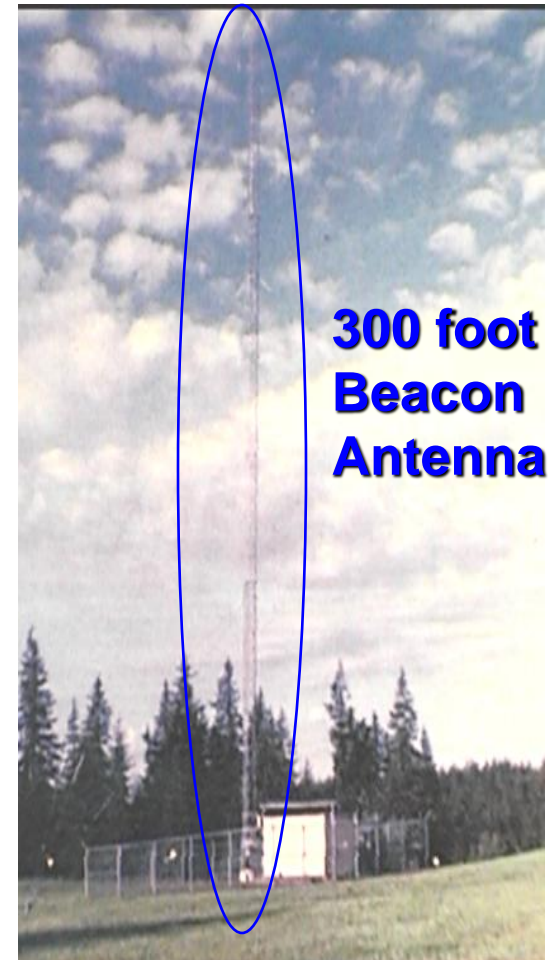


Reference &
Integrity
Antennas
*Two sets
of each*



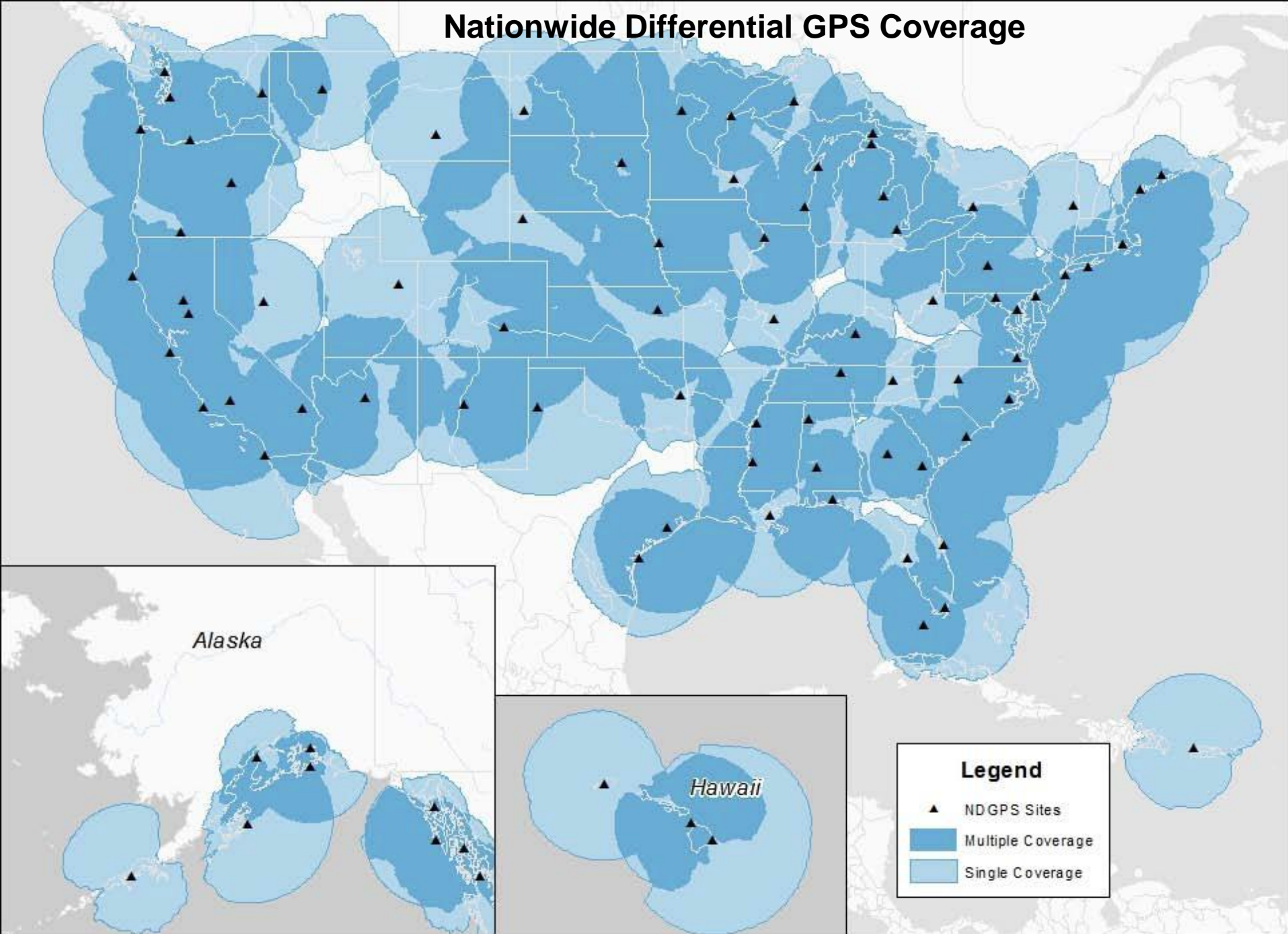
NDGPS Equipment
Shelter

There is a similar
shelter for the
25KW generator



**300 foot
Beacon
Antenna**

Nationwide Differential GPS Coverage



Source: 2010 Federal Radionavigation Plan

Worldwide DGPS Coverage

